(c) The very fine pyrite sparingly disseminated through the carbonaceous shales, herein described, seems to have resulted from the action of sulphur, from decaying animal and vegetable life, on the ferro-megnesian silicate fragments which are abundant in these sediments.

DONALD F. MACDONALD,
Commission Geologist

CULEBRA, C. Z.,
April 1, 1912

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

WASHINGTON MEETING, DECEMBER, 1911

THE thirteenth session of this society was held at the Carnegie Institution in Washington, D. C., on December 27–29, 1911, with President E. C. Pickering in the chair. There were sixty-four members of the society in attendance besides many friends. Nine persons were elected to membership, making a total of more than 270 members.

Six sessions were held, two of which were joint meetings with Section A of the American Association for the Advancement of Science. At the joint sessions Professor E. B. Frost presided in the double capacity of vice-president of Section A and first vice-president of the Astronomical and Astrophysical Society of America; and for these sessions a special program was arranged comprising addresses by Professor Lewis Boss on "Recent Researches as to the Systematic Motions of the Stars," by Professor E. H. Moore, retiring vice-president of Section A, on "The Foundations of the Theory of Linear Integral Equations" and by the Reverend Joel H. Metcalf on "The Asteroid Problem."

The society's scientific program included thirty-two papers and also reports from the committees on comets, photographic astrometry and cooperation in the teaching of astronomy. A new committee on asteroids was created with members, E. W. Brown (chairman), J. H. Metcalf, G. H. Peters and A. O. Leuschner.

The following members were in attendance at the Washington meeting: Misses L. B. Allen, H. W. Bigelow, A. J. Cannon, M. M. Hopkins, E. A. Lamson, Mary Proctor, S. F. Whiting, Messrs. A. T. G. Apple, E. E. Barnard, S. G. Barton, L. A. Bauer, L. Boss, J. A. Brashear, E. W. Brown, C. A. Chant, H. S. Davis, C. L. Doolittle, E. Doolittle, R. S. Dugan, J. C. Duncan, J. R. Eastman, W. S. Eichelberger, F. E. Fowle, E. Frisby, E. B. Frost, C. H. Gingrich, A. Hall, W. M. Hamilton, J. C. Hammond, H. B. Hedrick, G. A. Hill, W. J. Humphreys, H. Jacoby, H. H. Kimball, W. F. King, F. B. Littell, F. H. Loud, E. O. Lovett, C. A. R. Lundin, Jr., J. H. Metcalf, W. I. Milham, J. A. Miller, S. A. Mitchell, W. M. Mitchell, H. R. Morgan, C. P. Olivier, G. H. Peters, E. C. Pickering, J. S. Plaskett, R. W. Prentiss, W. F. Rigge, F. E. Ross, A. L. Rotch, H. N. Russell, F. Schlesinger, A. N. Skinner, H. T. Stetson, O. Stone, E. D. Tillyer, A. B. Turner, F. D. Urie, R. W. Willson, D. T. Wilson, R. S. Woodward.

New members were elected as follows: John August Anderson, Johns Hopkins University, Baltimore, Md.; Zaccheus Daniel, Allegheny Observatory, Pittsburgh, Pa.; Walter M. Hamilton, 2307 Washington Circle, Washington, D. C.; H. H. Kimball, Weather Bureau, Washington, D. C.; William Francis Rigge, Creighton University; Harlow Shapley, The Observatory, Princeton, N. J.; Vesto Melvin Slipher, Flagstaff, Ariz.; Albert Harris Wilson, Haverford, Pa.; Charles Clayton Wylie, Laws Observatory, Columbia, Mo.

The program of the meeting included the following papers and reports:

A Device for Facilitating Various Forms of Computation: E. W. BROWN.

The device consists of a frame and a carrier which supports a number of tapes. On these tapes small oblong pieces of cardboard are pasted, the members to be summed being written on the pieces of cardboard. It is essentially a device for avoiding the frequent rewriting of the same number when it has to enter into a calculation in many different ways. It is being used for the summation of many small harmonic terms at numerous time-intervals and for the formation of double-entry tables which consist of ten or more terms of the type $A \cos (i\theta + j\phi + a)$ where i, j are integers, a, A constants and θ, ϕ increase uniformly with the time. It will probably be also used for the analysis of numerous observations at equal time-intervals into harmonic terms whose periods are known or have been previously determined, as, for example, in obtaining the tidal constants of a port from hourly observations of the tide height.

The Lesson of Joseph Piazzi's Life: H. S. DAVIS.

Piazzi's career is followed from his birth, through

his student days in Milan, Turin and Rome, and his professional days in the universities of Genoa, Malta, Ravenna, Cremona and Rome, and while getting wider experience in Paris and Greenwich preparatory to beginning his long period of astronomical observations at Palermo, where he built an observatory on the royal palace.

The method of his observing for the large catalogue of stars, his discoveries of certain stellar proper motions, his wide range of observations and of writings on astronomical and geodetic subjects, are narrated to elucidate the influence which this Theatine priest exerted on the science of his and later days, and inversely to exemplify the influence which had been exerted on him by his environment and by his intercourse with Laplace, Lagrange, Delambre, Bailly, Cassini, Herschel, Wollaston, Oriani, Cagnoli and other notable men of astronomy. It is further shown how his discovery of Ceres was not altogether an accident, nor by any means his greatest achievement, but was the natural by-product of his plan of work and his persistent diligence; and that all the many and valuable fruits of his quarter-century of labor were but the outgrowth of an unselfish devotion that had adopted as its motto the words of Seneca: "At mehercules non aliud quis aut magnificentius quaesierit aut didicerit utilius, quam de stellarum siderumque natura."

(This paper will be published *in extenso* in "Makers of Astronomy," soon to be issued by the Fordham University Press, New York, as companion to "Makers of Electricity.")

The Astronomischer Jahresbericht (an Announcement): H. S. Davis.

A brief historical summary of the founding and maintaining of this review of astronomical publications, its plan and scope, and to what extent its purpose has been attained. Its future, since assumption of the editorship by Professor Dr. Fritz Cohn, on the retirement of Dr. Berberich, who succeeded to the editorship on the death of Professor Dr. Wislicenus, its founder.

The Variability of Polaris: Joel Stebbins.

The variation in the light of Polaris was detected by Hertzsprung and confirmed by King. Assuming the spectroscopic period of 3.9681 days, Hertzsprung found the light-curve to be approximately a sine-curve with double amplitude 0.17 mag., and King found a similar curve with variation greater than 0.10 mag. Both of these results were from photographs. Observations by the writer with the selenium photometer give a similar curve of the same phase, but of much smaller amplitude, the approximate range being 0.057 mag. It is highly probable that the amount of the visual variation is likewise about 0.06 mag.

The Asteroid Problem: Joel H. Metcalf.

In ninety years from January 1, 1801, to 1891, 323 asteroids were discovered. In the last twenty years about 427 have been added. The rapid multiplication of discoveries and the probable existence of 1,500 brighter than the 14th magnitude demands greater cooperation and division of labor in this field. Except for special investigations the work should be photographic, which gives great facility for observation of old asteroids as well as the discovery of new ones. The importance of the investigation in the light of the discovery of Eros and the Jupiter group of asteroids and the probable existence of still more interesting bodies is increasingly obvious.

Magnitudes, Colors and Spectra of Standard Stars within 17° of the North Pole: J. A. Parkhurst.

This paper describes the determination of the "visual" and photographic magnitudes, color-indices and spectral classes of all the stars down to the B. D. 7.5 magnitude, from declination + 73° to the north pole. There are 666 stars within these limits. The instrument used was a camera having a Zeiss doublet of "ultra-violet" glass, also a 15° prism of the same material. The aperture of each is 145 mm. and the focal length of the lens 814 mm.

The photographic magnitudes were taken from Seed plates exposed 6.5 mm. inside the focus, and the opacity of the images was measured with a Hartmann "mikrophotometer." To obtain the "visual" magnitudes images were taken in focus on Cramer trichromatic plates through a "visual luminosity" filter, and the diameters of the images measured under the microscope. The spectral classes were estimated on the Harvard system from the objective prism plates. The magnitude scale was determined on the "absolute" system, directly by sensitometer squares on the extra-focal plates, and indirectly through the Pleiades stars on the focal plates. The measures were reduced by using the Müller and Kempf Potsdam visual magnitudes of the white stars in each field, and reduced to the Harvard system by subtracting 0.29.

Curves were shown giving comparisons with the results of Schwarzschild, Müller and Kempf and Mrs. Fleming; also the relation between color-index and spectral class, and between the color-index and Müller and Kempf's estimates of color.

A Comparison of Dr. Peters's Celestial Charts with the Photographic Charts of the Sky: J. G. PORTER.

The value of star-charts lies, first, in the completeness with which they represent the sky, and secondly, in their availability for use at the telescope.

Four of the photographic charts of the sky, taken at Algiers and Bordeaux, were compared with Dr. Peters's celestial charts, the stars in corresponding regions being carefully counted. In every case the photographic charts contain fewer stars, the percentages running from 51 to 81, and the average being 67 per cent. That is, the visual charts contain on the average 50 per cent. more stars than the photographic charts.

Dr. Peters's charts are pretty complete down to the twelfth magnitude. The photographic charts, therefore, are by no means complete to the twelfth magnitude.

On the photographic charts the images of all but the brighter stars are too faint to see without brilliant illumination, and the configurations of the fainter stars are difficult to trace. Hence these charts are ill suited for use with the telescope.

Two conclusions follow from this comparison. First, the visual charts, so far from being superseded by the photographic charts, are much superior both in their fullness and in their practical usefulness.

Secondly, the photographic charts while ostensibly showing stars to the fourteenth magnitude, really go hardly lower than the eleventh and a half. Some of this discrepancy may be due to the difference between the photographic and visual scales; yet in any case it is clear that in the matter of these charts photography has accomplished far less than was claimed for it, and less than should have been done to justify the expenditure of time and money.

The New Twin Photographical Telescopes of the U. S. Naval Observatory: GEORGE H. PETERS.

This paper is a continuation of one given at the meeting of the society at the Yerkes Observatory in 1909, entitled, "On the Construction of Astronomical Photographic Objectives at the Naval Observatory." It describes the progress in construction and adjustment of the triple photographic objectives of 10 inches aperture and 110 inches focal length. These new lenses and their mechanical parts, forming a twin photographic telescope, are now practically completed, and are erected in position on the old 26-inch mounting. The tests for errors of adjustment in collimation and refraction are exemplified, together with the methods employed in correcting them.

The Use of Special Topics in Teaching Astronomy: SARAH F. WHITING.

The large numbers who should study elementary astronomy for information and culture should be taught to handle the books of an astronomical library and to express themselves clearly in connected discourse.

To these ends a method more frequently used in literary subjects may well be used—the method of "special topics." A large class for this exercise must be divided into parallel sections; the topics must be given out with bibliography and suggested outline, and the presentation of the topics before the class rated for excellence of outline, form of presentation in language and manner.

Such series of topics as the following have been found practical.

1. Historical topics, some of which may be presented in connection with the biographies of astronomers.

2. A series of topics to show the knowledge of astronomy at different epochs—astronomy of the Bible, astronomy of Homer, astronomy of Milton, astronomy of Shakespeare.

3. The progress of astronomy as related to instruments and mathematical methods. The development of the telescope, of calculus, logarithms, etc.

4. A set of topics to show the immense cost in money and labor to obtain facts—eclipse expeditions, expeditions to obtain solar parallax.

5. Great observatories.

6. Special studies of celestial objects—Halley's comet, net in Orion, etc.

The Orbit of the Spectroscopic Binary, β Scorpii: J. C. DUNCAN.

The variability of the radial velocity of the brighter visible component of β Scorpii was discovered by Dr. V. M. Slipher at the Lowell Observatory in 1903. In 1908 he found that the star's spectrum showed a sharp, non-shifting K line. The writer of the present paper has determined the orbit of the binary from seventy-nine spectrograms made by Dr. Slipher in 1908, 1909 and 1911.

Measurement of the spectrograms was rendered difficult by the scarcity and diffuseness of the spectral lines. In addition to the K line, two

lines of hydrogen and three of helium were all that could be measured. The H line of calcium is concealed by the broad H of hydrogen. On some of the plates the presence of the fainter component of the binary is made evident by the doubling of the lines of hydrogen and helium, so that on these plates three different velocities are indicated—that of each component of the binary and that of the K line.

The orbital elements derived are as follows:

	Bright Com.	Faint Com.
Period, P	6.8292	
Eccentricity, e ..	0.25	
Time of periastron, T	1908 July 2.98	
Dist. node to periastron, ω	20°	200°
Semi-amplitude of vel. curve, K ..	126 km./sec.	166 km./sec.
Maximum velocity	+150 km./sec.	+120 km./sec.
Minimum velocity	—102 km./sec.	—211 km./sec.
Projected semi-axis major, $a \sin i$ ..	11,457,000 km.	15,094,000 km.
Ratio of masses .	1: 0.91	
Velocity of system	—6.0 km./sec.	
Velocity of calcium	—16.4±0.6 km./sec.	

The velocity of the calcium differs by ten kilometers per second from that of the center of gravity of the binary system—a difference that seems too great to be explained by errors of measurement or of the assumed wave-lengths. Since a uniformly moving mass accompanying the system would be expected to have a velocity equal to that of the common center of gravity of the revolving stars, this investigation may be regarded as tending to support the hypothesis, favored by Slipher and others, of a detached calcium cloud in the line of sight.

There is some indication that the period is slowly lengthening. It is hoped that data derived from some older plates by Dr. Slipher may decide this point. This will also have a bearing on the question of the location of the calcium since, if the star is involved in a cloud of calcium or other substance, the friction should cause the period to shorten.

The Dissolution of Solar Prominences: FREDERICK SLOCUM.

Among the photographs of solar prominences at the Yerkes Observatory there are several series which show prominences in the act of dissolving. In general the prominences dissolve in one of the four following ways:

1. By floating up and dissipating like smoke from a fire.
2. By ascending and contracting into a long, fine filament.
3. By being torn into fragments and borne away as if by a strong wind.
4. By dissolving *in situ* like the trail of a meteor.

These processes were illustrated by lantern slides giving series of views of the prominences of June 19–20, 1911; September 19, 1911; July 25–29, 1908; March 25, 1910, and single views of other prominences.

All of the photographs were taken in the light of the H line of calcium with the Rumford spectroheliograph attached to the 40-inch telescope.

The Parallax of Nova Lacertæ 1910: FREDERICK SLOCUM.

Nova Lacertæ was discovered by Espin December 30, 1910. During the year 1911 ten photographs of the region around the Nova were made with the 40-inch telescope for the purpose of determining the parallax of the star. Cramer instantaneous isoplates were used in connection with a yellow color filter. In general two exposures were made on each plate. The exposure time was increased from 5 to 15 minutes as the star diminished from somewhat brighter than the 8th down to the 12th magnitude. Six comparison stars were selected as symmetrically situated as possible, and as near as possible to the mean brightness of the Nova. The parallactic displacement parallel to the ecliptic was measured. The value of the parallax came out $+ 0''.013$ with a probable error of $\pm 0''.014$. This would mean that the outburst observed in 1910 really occurred 250 years ago.

A Simple Pyrheliometer: W. J. HUMPHREYS.

This instrument consists essentially of a spherical Dewar bulb filled with mercury and provided with means for absorbing solar energy and measuring its effect.

A hollow platinum cone, polished on the inside, about seven centimeters long and with an opening one centimeter in diameter is symmetrically immersed in the mercury and set so that it will receive sunshine through a suitable system of diaphragms. Such a cone is well nigh a perfect absorber of radiation parallel to its axis, and as constructed the heat absorbed is rapidly transmitted to the mercury, the expansion of which is measured in a thermometer stem.

The readings consist in taking the time interval during the expansion of the mercury up the ther-

mometer stem from one to another fixed point. Provision is made whereby, after one time interval has been obtained, the mercury can be set back below the first mark, and then another interval read, and so on as long as necessary.

The intensity of the insolation is inversely proportional, approximately, to the above time intervals—the times required for delivering substantially equal amounts of heat to the mercury.

While capable of development as a standard it was designed as a secondary instrument, the chief features of which are:

1. Essentially complete absorption of insolation.
2. Unchanging coefficient of absorption.
3. Highest possible heat insulation.
4. Freedom from calibration.
5. Ease of manipulation.

The Violle Actinometer as an Instrument of Precision: F. W. VERY.

The principal objects of this research are to show that the Violle actinometer may be used either dynamically or statically with equal precision, and to develop the theory of its static use.

Hitherto the rates of cooling of a thermometer in a partial vacuum have been used to get an estimate of losses by convection in an actinometer in air, but these measures have not differed essentially from the experiments of Dulong and Petit, and are quite inadequate, since they entirely neglect the losses by penetration of gaseous molecules. It is very commonly assumed that the velocity of cooling in "vacuum," obtained by Dulong and Petit,

$$V = k((1.0077)^{t+\theta} - (1.0077)^{t}),$$

represents a law of *radiation;* but this is not the case, since the observations included both radiation and penetration, and the latter is by no means insignificant.

By the use of Stefan's law for pure radiation, I first separated the radiant component, and from experiments by Langley and myself, and by Kundt and Warburg, I derived a preliminary value of the penetration in C.G.S. units,

$$P = 0.0001397\,\theta.$$

This, however, did not represent the observations so closely as could be wished, and it was evident that dimensions and form of both radiating body and enclosure must enter into a complete theory. Taking Winkelmann's value of K (the constant of penetration for a plane surface in C.G.S. units), calling r the radius of the thermometer-bulb, l the distance to the enclosing surface, and θ the temperature of excess, and reducing to minutes,

$$P = 4K\theta \times \frac{4\pi r^2}{l} \times 60.$$

With this formula the penetration was computed for two thermometers used by Langley on Mount Whitney in a Violle actinometer with the following result:

$\theta = 30°$ C., Green 4,572, cooling per minute by penetration, $-2°.248$; observed, $-2°.08$.

$\theta = 30°$ C., Baudin 8,737, cooling per minute by penetration, $-2°.588$; observed, $-2°.84$.

The convection loss can be represented by the formula

$$C = c \times \theta^{1.233} \times (p/p_1)^{0.45},$$

where

$$c = 0.000{,}005{,}02 + \frac{0.000{,}036{,}76}{r} \text{ (C.G.S.)},$$

a value determined by myself. p and p_1 are actual and normal barometric pressures, and the exponents are those of Dulong and Petit. For the given excess and Baudin thermometer,

Loss of temperature per minute by convection $= -4°.158$

Loss of temperature per minute by penetration $= -2°.588$

Loss of temperature per minute by radiation $= -2°.890$

Computed total loss $= -9°.636$

Found $= -9°.2$

The final difference of about 0°.4 includes errors of observation and also stem conduction which in this case was towards the bulb, or positive, the thermometer having been previously heated as a whole.

With some minor emendations relating to the general theory of the instrument, which can not be described here, I obtained from Keeler's observation with the Violle actinometer on the summit of Mt. Whitney:

Solar radiation at noon from initial rate of heating $= 1.995$ cal. per sq. cm. per min.

Solar radiation at noon from static temperature $= 2.001$ cal. per sq. cm. per min.

The difference in the results by the two methods is insignificant.

Improvements are suggested in the mounting and use of the instrument, and certain necessary precautions which have sometimes been neglected are described.

The Revised Draper Catalogue: ANNIE J. CANNON.

Owing to a general desire among astronomers for the class of spectrum of many more stars than have yet been studied, work has been begun upon a new catalogue of stellar spectra, to be called the Revised Draper Catalogue. The whole sky will be covered by photographs taken with a prism placed in front of the object glass of the 8-inch Draper and Bache telescopes, the exposure being generally one hour. It is believed that all stars of the eighth magnitude will be included, as well as many fainter ones. All the classification will be made by the writer, using the notation described in the *Harvard Annals,* volume 56, pages 66 to 69.

This work can be done rapidly, since previous study and classification of more than five thousand spectra taken with the various Harvard telescopes have made each division and subdivision a definite picture in the mind. Three assistants are working daily upon the laborious identifications, the reductions and the clerical part of the catalogue. Seven thousand spectra have already been classified, and it is estimated that if we have equally good photographs for the whole sky, the catalogue will contain one hundred thousand stars. It is proposed to print it in sections in the order of right ascension, of which the portion from 0^h to 6^h will form the first volume.

Notes on the Determination of the Elements of Algol Variables: H. N. RUSSELL.

Further study of this problem on which a report was made to the society in August, 1910, shows that, when there is no constant period at minimum (*i. e.,* when the eclipse is partial), it is possible to represent the observed light curve within the error of ordinary observations by arbitrarily choosing any value within certain limits for the ratio of the radii of the two stars, and then determining the other elements in a suitable manner.

The various sets of elements, however, give different depths for the secondary minimum; and if this has been observed the problem becomes determinate, unless the primary and secondary minima are of nearly equal depth. In the latter case additional data (which can sometimes be supplied by spectrographic observation) are necessary if the elements are to be definitely determined.

Tables have been prepared which facilitate the numerical solution of these problems. With slight modifications, these may also be used in the case of variables of the Beta Lyræ type, in which the two stars are very close, and are distorted into prolate ellipsoids by their mutual attraction.

The Eclipsing Variables W Crucis and W Ursæ Majoris: H. N. RUSSELL.

Good light-curves of these stars have been determined, the first at Harvard by Miss Leavitt, the second at Potsdam by Muller and Kempf and by Baldwin. Both are of the β-Lyræ type, and in each case the observations can be very satisfactorily represented on the eclipse theory.

W Crucis has a period of 198.5 days and a range from $8^m.9$ to $9^m.5$, with a secondary maximum of $9^m.2$. The system consists of two stars, one twice as bright and two and a half times as large as the other. The ratio of the longer and shorter axis of the ellipsoidal stars is 7:6. The relative orbit has an eccentricity of 0.04, and at periastron the surfaces of the two stars are separated by a distance slightly exceeding the diameter of the smaller. At principal maximum the smaller star is totally eclipsed by the larger. Increase and decrease of light lasting 14 days and totality 15 days.

The density of the larger star can not exceed 1/160 that of the smaller star, 1/10 that of the air under ordinary conditions. The spectrum is G pec. with bright lines.

This system is evidently in a very early stage of development, and if comparable with the sun in mass and surface brightness, must be at a distance of many thousand light-years.

The writer is greatly indebted to Professor Pickering and Miss Leavitt for unpublished observations of this star.

W Ursæ Majoris varies from $7^m.9$ to $8^m.5$ in a period of 8 hours, within which there are two equal and equidistant maxima and minima. Its variations may be very satisfactorily represented on the assumption that the system consists of two stars, equal in size and brightness, with longer axes 4/3 of the shorter axes, revolving in a circular orbit, and separated by only 2/5 of their longer diameters. At maximum one star obscures half the disk of the other, the eclipse lasting one and a half hour.

The light-curve may be equally well represented with any ratio of the two radii between unity and 0.57—the surface brightness of the two stars being equal. The mean density of the system is 2.4 times the sun. This star is also of Spectrum G, but must represent a very different stage of evolution from the other.

The Solar Rotation: J. S. PLASKETT.

This paper gives an account of further work on the spectroscopic determination of the solar rota-

tion, a preliminary paper having been given at the last meeting. It includes a discussion of the measures of 110 spectra at seven different latitudes in the region $\lambda\,5{,}500$–$\lambda\,5{,}700$ and of 24 spectra at the equator in the region $\lambda\,4{,}200$–$\lambda\,4{,}300$. The value of the rotational velocity at the equator is at

$$\lambda\,5{,}600,\quad v + v_1 = 2.021 \pm .003 \text{ km.}\quad \xi = 14^\circ.35,$$
$$\lambda\,4{,}250,\quad v + v_1 = 2.012 \pm .003 \text{ km.}\quad \xi = 14^\circ.29,$$

where $v + v_1$ is the linear and ξ the daily angular sidereal velocity. The law of equatorial acceleration or polar retardation follows the Faye form, having the following coefficients:

$$v + v_1 = (1.306 + .701 \cos\phi)\cos\phi$$
$$= 10^\circ.84 + 3^\circ.51 \cos^2\phi.$$

A comparison of ξ for different determinations gives

Sun Spots	Faculæ	Flocculi	Reversing Layer			
			Duner	Halm	Adams 1906–7	Plaskett
14.40	14.62	14.55	14.81	14.53	14.63 1908 14.61	14.35

Whether the smaller value obtained here is due to some systematic error or to a variation in the rate of rotation there is as yet insufficient evidence to determine. It may be pointed out that the Ottawa observations were obtained at sun-spot minimum and the major part of the others more towards maximum.

A comparison of the residuals from lines of different elements in both regions indicates that any systematic deviations found, not greater except in one case than one third the average residual, are due to some personal systematic effect in measurement and not to differences of the rotational velocity in different elements.

The Moon's Mean Parallax: F. E. ROSS.

The following values of the lunar parallax and related quantities are based upon the constants of the geoid obtained in 1909 by the U. S. Coast and Geodetic Survey and upon Hinks's value of the moon's mass.

$$P_0 = 3{,}422''.526 \pm 0''.012,$$
$$\Delta = 238{,}857.9 \pm 1.1 \text{ U. S. statute miles,}$$
$$S = 1{,}079.93 \pm 1.04 \text{ miles,}$$
$$D = 0.6043 \pm .0003.$$

P_0 is the constant of the sine parallax, Δ the mean distance, S the semi-diameter, and D the density in terms of that of the earth. The correction to Hansen's parallax is

$$\delta H = +\,0''.45.$$

Observations on the moon's limb for the determination of the parallax seem to be subject to large systematic errors. The results obtained by Olufsen, Henderson, Breen, Stone and Batterman lead to a value of 304 for the reciprocal of the earth's flattening. This systematic error seems to be largely eliminated in the recent Greenwich-Cape series of observations on the lunar crater Moesting *A*. The value of the reciprocal of the flattening resulting from this series is 294.45. It is likely that considerable further improvement in the results by the observational method would be obtained by the adoption of a photographic method.

The Secular Variations of the Elements of the Orbits of the Four Inner Planets: ERIC DOOLITTLE.

This paper presents the results of a computation extending over upward of sixteen years which had for its object a new determination of the perturbations of the orbits of the inner planets based on the most accurate elements now obtainable. The method employed differed from that of Le Verrier and Newcomb in that it depended upon the evolution of certain integral expressions instead of on the use of infinite series. Every possible device to insure accuracy was employed, the entire computation being duplicated and all known test equations applied. The well-known discrepancies which exist between certain of the variations as derived from theory and their values as determined from observation merely were fully confirmed. The figures expressing the motions of the perihelion of Mercury, the node of Venus, the perihelion of Mars and the eccentricity of Mercury, respectively, are as follows.

Newcomb	New Computation	Observation
$+\,109''.76$	$+\,108''.91$	$+\,118''.24$
$-\,106''.00$	$-\,106''.00$	$-\,105''.40$
$+\,148''.80$	$+\,148''.74$	$+\,149''.55$
$+\quad 4''.24$	$+\quad 4''.235$	$+\quad 3''.36$

The Language of Meteorology: C. F. TALMAN. (Introduced by W. J. Humphreys.)

Scientific language is nowadays a somewhat neglected subject, and contemporary men of science show a reluctance to label their contributions to knowledge.

In meteorology there is need not only of new terms, but of a much more general use of the terms already introduced and adapted to their

purpose. A very large part of the meteorological vocabulary is unfamiliar to meteorologists. This is illustrated by the case of the "isograms." Upwards of eighty of these lines have been given appropriate names; but not a score of these names are in current use.

In no branch of science is the vocabulary more confused than in atmospheric optics; especially in English. One can hardly write of any but the commonest photometers without defining almost every term one uses. Thus the words "glory," "corona," "aureole" and "anthelion" are variously applied and interchanged; the Brocken specter is confused with the Brocken bow; etc.

Among meteorological neologisms the term "aerology," meaning the branch of science concerned with free-air investigations, deserves a wider use; "stratosphere" is the best name for the region of the atmosphere now more generally called the "isothermal layer"; Arctowski's terms "pleion" and "antipleion" are useful additions to the vocabulary; Dr. H. R. Mill's discrimination of "mean," "average" and "general" will obviate the confusion that heretofore reigned in the use of these words; the application now given in Great Britain to the terms "rime" and "glazed frost" is commended to general attention; L. Besson's name "nephometer" seems appropriate for an instrument used to measure the amount of cloudiness; the derivatives of the new German names for the snow-gauge ("chionometer," "nivometer") are likely to come into general use (*i. e.*, we shall use "nivometric," etc., though we may not adopt the noun); Odenbach's "ceraunograph" is a good international name for the thunderstorm-recorder; the American name "kiosk" gives us a tolerable English equivalent for "Wettersaüle."

An international commission on meteorological terminology is an urgent desideratum.

Can Astronomy Derive Benefit from the Dissemination of Esperanto? F. H. LOUD.

The paper first pointed out some of the easily verifiable indications of the entrance of Esperanto upon the stage of practical utility in the ordinary relationships of life, and proofs of the increasing popular acquaintance with it, especially in Europe; and then, passing to the consideration of its possible utilization in the service of astronomy, suggested its employment (1) in the oral discussions and the reports of international conventions, (2) in astronomical treatises, where, in the field of pure mathematics, for instance, such an example has already been set as the work of Dr. Cyril Vörös, of Budapest, on "Absolute Geometry"—a book (including its three sections) of 439 pages, and of high scientific value, and (3) in the dissemination of astronomical news, through the *Internacia Science Asocio* and other channels, where, though the direct service were rather to the general public than to professional astronomers, yet the science would ultimately receive benefit.

On the Flexure of a Meridian Circle: W. S. EICHELBERGER and H. R. MORGAN.

From 1903 to 1911 the flexure of the 9-inch transit circle of the Naval Observatory was determined from measures on collimators. The circle was shifted for each of the six clamp years, and at the end of the work, and the circle flexure distinguished from the tube flexure.

The table gives the division of the circle at the object glass end, the means of the measures on the collimators for each position, and the residuals from the solution of the fourteen equations.

The first eight equations result from 70 sets of measures on the horizontal collimators, and the last six from 68 sets of measures on the vertical collimator and nadir.

	O	Wt	$O-C$
$x_s + y \cos (A - 270° \ 4')$ =	$-0''.95$	3	$+0''.11$
$x_s + y \cos (A - 269° \ 56')$ =	$-1''.14$	6	$-0''.08$
$x_s + y \cos (A - 264° \ 52')$ =	$-1''.02$	6	$-0''.04$
$x_s + y \cos (A - 259° \ 40')$ =	$-0''.74$	13	$+0''.16$
$x_s + y \cos (A - 256° \ 28')$ =	$-0''.99$	18	$-0''.15$
$x_s + y \cos (A - 261° \ 34')$ =	$-0''.89$	6	$+0''.04$
$x_s + y \cos (A - 261° \ 16')$ =	$-0''.85$	9	$+0''.07$
$x_s + y \cos (A - 81° \ 16')$ =	$+0''.35$	9	$0''.00$
$x_c - y \sin (A - 264° \ 52')$ =	$+1''.08$	10	$+0''.12$
$x_c - y \sin (A - 259° \ 40')$ =	$+0''.85$	14	$+0''.17$
$x_c - y \sin (A - 256° \ 28')$ =	$+1''.13$	12	$+0''.08$
$x_c - y \sin (A - 261° \ 34')$ =	$+1''.07$	14	$+0''.07$
$x_c - y \sin (A - 261° \ 16')$ =	$+0''.93$	9	$+0''.07$
$x_c - y \sin (A - 81° \ 16')$ =	$-0''.96$	9	$-0''.03$

The solution gave: the coefficient of the sine flexure of the tube, $x_s = -0''.289$; the coefficient of the cosine flexure of the tube, $x_c = +0''.037$; the coefficient of the flexure of the circle, $y = +1''.156$; the point of maximum weight of the circle, $A = 137° \ 55'$. To test the sine law, 264 direct and reflected star observations were taken, on both clamps, and both sides of the zenith. The solutions in the table give the error of the nadir, or cosine flexure; a term for bisection error, or other discontinuity at the zenith; and the sine flexure.

Cla'p	No. Nights	½(R—D)	Mean Residual
E	5	$-0''.71 \pm 0''.34 - 1''.14 \sin z$	$\pm 0''.19$
W	2	$-1''.11 \pm 0''.34 - 1''.11 \sin z$	$\pm 0''.15$
W	4	$-1''.01 \pm 0''.83 - 1''.11 \sin z$	$\pm 0''.15$
W	2	$-1''.60 \pm 0''.40 - 1''.11 \sin z$	$\pm 0''.17$
W	2	$-1''.48 \pm 0''.28 - 0''.58 \sin z$	$\pm 0''.16$
W	2	$-1''.07 \pm 0''.71 - 1''.37 \sin z$	$\pm 0''.18$
E	2	$-0''.81 \pm 0''.22 - 0''.77 \sin z$	$\pm 0''.28$

The agreement with the collimator measures is satisfactory. To test the cosine law, 20,000 star observations, corrected for division error, bisection error, variation of latitude and flexure, were differenced for successive clamp years. The mean values of $(S_w - S_e)$ are:

$-0''.24, \ -0''.23, \ -0''.23, \ -0''.03, \ -0''.11.$

The residuals from these means were solved in the form

$$0''.04 \cos z - 0''.11 \cos 2z.$$

This reduced the mean residual from $0''.09$ to $0''.08$, only, and has not been used. The mean differences $(S_w - S_e)$ were attributed to the uncertainty in the various nadir division errors. The corrections, following, were, therefore, applied to the different years; their sum is zero:

$+0''.17, -0''.07, +0''.16, -0''.07, -0''.04, -0''.15.$

Tests with Standard Electric Lamps: E. S. KING.

These tests relate to two lamps, rated for 2-candle power, loaned from the Bureau of Standards at Washington. In comparing these lamps with the Argand Standard, I have included 6 commercial lamps, which were regulated to approximately the same intensity. The results for 8 comparisons, made at intervals of about a day, show great constancy. The average deviation in magnitudes for Lamp No. 1 is $\pm$ 0.035, for Lamp No. 2 $\pm$ 0.031, for the mean of the 6 commercial lamps, $\pm$ 0.030 and for the mean of all the lamps $\pm$ 0.025.

Comparisons with ten different stars were made by the out-of-focus method with the 11-inch Draper telescope on seven different nights. The resulting photographic magnitudes for the lamps at a distance of 1 meter are as follows: Lamp No. 1, 12.02; Lamp No. 2, 12.10; Lamp No. 8, 12.01. From the comparisons with the Argand the results are, Lamp No. 1, 12.05; Lamp No. 2, 12.12; Lamp No. 8, 12.04. These figures indicate that the lamps must be placed at a distance of about a kilometer to have the same photographic brightness as Polaris.

Recent Interviews with Optical Glass Manufacturers of France and Germany: J. A. BRASHEAR.

Some Observations with the 60-inch Reflecting Telescope of the Mt. Wilson Solar Observatory: E. E. BARNARD.

Photographic Observations of Brook's Comet 1911: E. E. BARNARD.

This comet when found by Brooks was a faint object without any tail. A long exposure photograph a few days after its discovery showed only a round diffused object with no signs of a tail. Later the comet developed a tail, and became visible to the naked eye and presented a splendid spectacle in the evening and then in the morning sky. Its naked eye visibility was of long duration, from August to December.

Though it developed a slender tail early in its career it was very disappointing, for photographs made night after night did not show any changes worth mentioning and the comet promised to be of little interest from a photographic standpoint. The photographs on different nights simply repeated themselves. In October, however, there was apparently a complete transformation of its nature and it really became one of the most interesting comets yet photographed. From the previous condition of a steady outflow of matter which marked its appearance until October the tail now presented a very active and remarkable appearance changing from day to day from one complex and beautiful form to another equally remarkable. The photographic activity was also greatly increased, much more, apparently, than its increase of light would account for. The phenomena of Morehouse's comet were duplicated in almost every particular. This change in the nature of Brook's comet did not seem to be due to any special change in its spectrum. Cyanogen did not appear at any time in the spectrum of the tail, though it was present in the head. This compound which was such a striking feature of the spectrum of the tail of Morehouse's comet was supposed to be the cause of the remarkable phenomena of that comet. Its absence from the tail of Brook's comet would seem to show that after all it was not necessarily the cause of the freakish nature of that comet.

Personal Equation Apparatus for Nine-inch Transit Circle, Naval Observatory: F. B. LITTELL.

The new personal equation apparatus recently installed is based on the same principle as that devised by Professor John R. Eastman, U.S.N., but differs entirely in details and secures a much more exact reproduction of the circumstances of actual observation and more extended application.

An artificial star moves alternately east and west across the line of sight at the focus of the

north meridian mark, a small electric motor furnishing the motive power. The speed can be varied to represent that of any star from 0° to 89° of declination. The apparent magnitude of the star may be varied by interposing screens in the line of sight, or by changing the resistance in the electric-light circuit.

This star will be observed by the use of the transit circle, just as an actual star would be observed, the movement of the carriage carrying the star in the meantime causing a similar automatic record to be registered on the chronograph. A complete observation includes the observation of the star during its east and west movement, using a reversing prism at the eyepiece to keep the apparent direction the same. By comparing the observer's record of such an observation with the automatic record, his absolute personal equation can be determined, and by suitable series of observations, the personal equations of various observers dependent on velocity and direction of motion, or magnitudes of stars, and for such objects as the limbs of the sun, moon, etc., may be determined.

At present nearly all star catalogues are more or less affected by such errors. Even if a self-registering right ascension micrometer and a reversing prism are used, by which many errors are greatly reduced, it is still desirable that observers should determine them, and if necessary apply corrections for them.

Measures of the Satellite of Neptune, and of Oberon and Titania, Satellites of Uranus, made at the Naval Observatory, 1908–10: ASAPH HALL.

After the publication, in 1875 and 1885, of the measures made at the Naval Observatory of the satellite of Neptune, Mr. Marth pointed out the curious motions of N and I, which determine the position of the satellite's orbit plane with reference to the equator. It has been explained that these motions might be produced by a flattening of the planet which causes the pole of the plane of the satellite's orbit to describe uniformly a small circle about the pole of the planet.

Therefore, for the purpose of following these motions, the satellite of Neptune has been measured at the Naval Observatory during many oppositions.

For the two oppositions 1908–09 and 1909–10, the following corrections have been obtained to the data of the Connaissance des Temps, which are the elements of H. Struve published in 1894:

1908–09	1909–10
$du = +1^\circ.223 \pm 0^\circ.190$	$du = +0^\circ.521 \pm 0^\circ.162$
$dN = +1.341 \pm 0.383$	$dN = +1.097 \pm 0.313$
$dI = +0.401 \pm 0.376$	$dI = -0.277 \pm 0.294$
$Q = 179^\circ.51$	$Q = 37^\circ.34$
$e = 0.002,71$	$e = 0.009,60$
$da = +0''.344 \pm 0''.056$	$da = +0''.058 \pm 0''.045$

The corrections to u, N and I are believed to be real. Evidently there is a considerable change of personal equation in the distance pointings, as has been shown already in the measures of several observers.

The measures of Neptune's satellite made some years ago at the Yerkes Observatory by Professor Barnard with the 40-inch refractor, give for the semi-major axis of the orbit at the mean distance of the planet from the sun, 16″.22, instead of 16″.27, which is usually accepted.

On account of the large aperture of the telescope employed, this determination appears to be the most accurate of the visual measures, and least liable to systematic errors.

Various experiments have been made at the Naval Observatory with reference to the elimination of systematic errors, including the use of reversing prisms. However, with the prisms employed, so much light is lost that they can be used only on very good nights.

For Oberon and Titania, satellites of Uranus, the following corrections have been obtained to the elements of the Connaissance des Temps from observations made at the oppositions of 1908, 1909, 1910:

Oberon	Titania
$du = +0^\circ.767 \pm 0^\circ.207$	$du = +1^\circ.340 \pm 0^\circ.262$
$dN = -0.077 \pm 0.360$	$dN = -0.634 \pm 0.474$
$dI = -0.611 \pm 0.347$	$dI = -0.730 \pm 0.412$
$Q = 218^\circ.41$	$Q = 216^\circ.45$
$e = 0.0100$	$e = 0.0934$
$da = +0''.167 \pm 0''.119$	$da = +0''.139 \pm 0''.090$

From measures secured in 1911 by Mr. Eppes and Mr. Burton, Mr. Eppes has found the following corrections to the data of the Connaissance des Temps:

Oberon	Titania
$du = +0^\circ.735 \pm 0^\circ.179$	$du = +1^\circ.778 \pm 0^\circ.159$
$dN = -0.263 \pm 0.261$	$dN = -0.253 \pm 0.295$
$dI = +0.221 \pm 0.235$	$dI = +0.033 \pm 0.271$
$Q = 60^\circ.06$	$Q = 285^\circ.02$
$e = 0.00214$	$e = 0.00180$
$da = +0''.072 \pm 0''.074$	$da = +0''.208 \pm 0''.075$

The Paris Conference of October, 1911: W. S. EICHELBERGER.

At the recent conference of the directors of the several national nautical almanacs held in Paris in October, 1911, cooperation among the respective offices was recommended to their several governments. A full account of the work of the conference is contained in the *Astronomische Nachrichten,* No. 4535, for November 12, and in *Nature* for November 30.

Attention was called particularly to three of the resolutions adopted by the conference.

1. The conference strongly recommends that the ephemerides of the stars, that is to say, their correction from mean to apparent place, should be calculated for the upper transit at the meridian of Greenwich.

2. The conference is of the opinion that the adoption of the meridian of Greenwich for all ephemerides should be realized as soon as possible.

3. The ordinary ephemerides of the stars shall be calculated to $0^s.001$ in right ascension so far as 60° of declination and $0''.01$ in declination.

The first two resolutions quoted imply that each office in computing results which are to be furnished the other almanacs will do so for the Greenwich meridian. The question naturally arises with reference to the *American Ephemeris,* for instance:

1. Should the ephemerides for the physical observations of the sun, moon and planets and the ephemerides of the satellites of Mars, Uranus and Neptune which will be computed by the office of the *American Ephemeris* for Greenwich mean noon and in that form furnished to the other almanacs, be printed in our almanac for Greenwich mean noon, or is there sufficient reason to require us to make the necessary additional computations to enable us to publish these data for Washington mean noon as at present?

2. Should the apparent places of the stars which will be furnished to the office of the *American Ephemeris* by the European almanac offices for superior passage over the meridian of Greenwich be published in our almanac for transit at Greenwich or transformed to transit at Washington as at present?

3. Is it to the advantage of astronomers in general to have the apparent places of stars given to $0^s.001$ in R.A. so far as 60° of declination and $0''.01$ in declination?

It is not intended to increase the labor of computing to obtain the additional decimal, but simply to publish the additional decimal which is at present always computed in the various almanac offices. Nor is it intended that this last decimal shall be accurate to within a unit. In fact it may be in error several units. The object in publishing the additional decimal is to permit any one to interpolate to the time of observation, the apparent place as given; to apply the short period terms for whose calculation convenient tables will be provided; and finally to obtain his computed right ascension at the time of observation accurately to the hundredth of a second of time and his declination to the tenth of a second of arc.

It is upon these questions that the Naval Observatory would like to have an expression of opinion from the astronomers of the country.

The Spectrum and Orbit of β Scorpii: Z. DANIEL and F. SCHLESINGER.

This is one of the spectroscopic binaries (discovered by Slipher at the Lowell Observatory) for which the H and K lines, due to calcium, appear to be nearly or quite stationary. Only two of these objects have thus far been studied: δ-Orionis by Hartmann and o-Persei by Jordan. From 73 spectrograms secured in 1911 with the Mellon spectrograph of the Allegheny Observatory, the following elements have been derived by means of a least-squares solution.

$$\begin{aligned} P &= 6.8283 \text{ days} \pm 0.0001 \text{ day}, \\ K &= 125.66 \text{ km.} \pm 1.18 \text{ km.}, \\ e &= 0.270 \pm 0.008, \\ T &= \text{J.D. } 2419163.923 \text{ G.M.T.} \pm 0.034 \text{ day}, \\ \omega &= +20°.1 \pm 2°.2, \\ \gamma &= -11.0 \text{ km.} \end{aligned}$$

Measurements of the secondary spectrum could also be made on some plates, and these yield

$$\begin{aligned} K_S &= 197 \text{ km.} \pm 10.5 \text{ km.}, \\ m \cdot \sin^3 i &= 13.0, \\ m_S \cdot \sin^3 i &= 8.3, \end{aligned}$$

the unit of mass being that of the sun. Using Rowland's wave-length for the K-line, the mean velocity derived from it is -8.6 km. $\pm$ 1.7 km., which is not far from that of the center of mass of the system, a result in accord with those for δ Orionis and o Persei.

Report of the Committee on Comets, December, 1911: G. C. COMSTOCK (chairman).

Owing to the absence of its chairman abroad during a major portion of the past year the work of the committee on comets has consisted mainly

in the accumulation and tabulation of replies to its circular letter relative to photographs of Halley's comet. From these replies there has been constructed a card catalogue exhibiting in chronological order the material available for a photographic history of this comet during its appearance of 1910. At present this catalogue consists of about a thousand titles, but it can not be regarded as complete, owing to the absence of reports from several important sources.

Correspondence is being conducted in the endeavor to supply as far as may be the missing data, but it is already apparent that the existing gaps can not be completely filled. A period of very great activity in photographing the comet accompanies the date of its nearest approach to the earth, but this is preceded by an epoch of comparative neglect and is followed, in July, 1910, by an apparently complete cessation of photographic work upon the comet, continuing until December, when some exposures were made at the Lick Observatory and reported to the committee. It is earnestly hoped that these lacunæ will be filled by observations not yet reported to the committee.

As soon as the card catalogue can be regarded as reasonably complete it is the purpose of your committee to select from it such data for reproduction as will best serve its purpose of constructing a graphic history of the comet's appearance in the years 1909–10.

Report of the Committee on Photographic Astrometry: F. Schlesinger (chairman).

The chairman reported briefly on the progress made since the meeting at Ottawa four months earlier, at which a full report had been read. It appears that the most immediate duty of this committee is to study the movements of a pier during the course of a night, and if possible to devise some method by which a pier can be kept stationary within small amounts. For this purpose a 10-inch photographic telescope of 100 inches focal length has been constructed, and is now being mounted upon a pier at the Allegheny Observatory. The pier and telescope are to be kept at a nearly constant temperature in a basement room at the observatory. At frequent intervals throughout the night, short exposures are to be made upon the region of the pole, access to this part of the sky being obtained through a window of plane parallel glass. Dr. Schlesinger also referred briefly to the progress made by Dr. Ross with the photographic zenith-tube designed by the latter and mounted by him at the International Latitude Station at Gaithersburg. The material thus far secured indicates a considerable reduction in accidental errors, as compared with the best work of the zenith telescope by Talcott's method. This instrument had been in operation during a few months only, and consequently no information is as yet forthcoming as to the freedom of the method from systematic error.

A verbal report by Professor C. L. Doolittle, chairman of the committee on cooperation in the teaching of astronomy, was followed by an extended and profitable discussion.

Late in the afternoon of Friday, December 29, the society adjourned to reassemble at the Allegheny Observatory, Pittsburgh, in the following August.

R. H. Curtiss,
Editor for the Meeting

Ann Arbor,
February, 1912

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

The meeting of the Academy of Science of St. Louis was held at the Academy building on Monday, March 18, 1912, at 8 P.M., President Engler in the chair.

Professor C. A. Waldo, of Washington University, addressed the academy on "The Problems of Coal Exhaustion."

"Miniature Flint Arrows" was the subject of a short paper by Dr. H. M. Whelpley, who illustrated his remarks with over 2,000 specimens, varying in length from .06 to 1 inch. In form they represent all of the common types of ordinary arrows and were evidently made by the same process of pressure chipping. Specimens have been found in England, Spain, Belgium, India, Palestine, Egypt and the United States. These artifacts belong to the Neolithic age. It has been suggested, but without evidence, that they were made by a pygmy race of human beings. It is also claimed that they were barbs for harpoons, tattooing instruments, fish snags or drills for skin and shell work. Dr. Whelpley concludes that the medium size and larger miniature arrows, such as are very plentiful along portions of the Missouri and Meramec Rivers, were used as arrow heads. The most minute ones he considers examples of skill in flint chipping, the same as the miniature baskets made by the Pomo Indians to-day are merely examples of skill in basketry.